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Blood fluorescence polarization characteristics of saturated fatty acid biological effects

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ABSTRACT

The fluorescence spectra of normal and lard diet intake whole blood solution induced by a laser with an excitation wavelength of 407 nm, and the polarization fluorescence spectra at angles of 0°, 35°, 55° and 90° were studied experimentally. The polarization state was tested by fluorescence intensity Stokes vector parameters. Through Mueller matrix calculations, we discuss the polarization degrees of whole blood solution during different time, the effects on fluorescence parameters of whole blood solution after lard diet intake. The results show that both the main fluorescence peaks of normal and lard diet intake whole blood solution locate at about 612 nm. The polarization degree of the whole blood solution after lard diet intake fluctuates greatly and is evidently higher than that of normal one. It is analyzed that growing blood cells in size and increasing blood viscosity make the molecular rotation of lard diet intake hindered.

1. Introduction

An individual's diet of fats can impact their long-term health. For instance, cardiovascular and cerebrovascular diseases, which commonly effect elderly patients, are induced by influenced by abnormal blood lipids. This abnormal lipid is caused by an imbalanced diet of fatty acids commonly found in fats and oils [1–6]. The properties and effects of fatty acids depend on their varieties and chain length. Fatty acids include saturated fatty acids (SFAs) and unsaturated fatty acids (UFAs). In the SFAs, low density lipoprotein cholesterol and triglyceride dominate. These two components could easily cause to hypertension, coronary heart disease, vascular sclerosis and miocardial infarction etc [7–10]. Nutritional fats and oils contain both saturated and unsaturated fatty acids. They constitute one of the major categories of food products, as they contain many nutrients which are closely related to human health [11–15]. The role of dietary fats and oils in human nutrition has been one of the most important areas of concern and investigation in the field of nutrition science for decades. Fats rich in saturated fatty acids generally tend to increase serum cholesterol.

Fluorescence measurements with higher sensitivity and strong selectivity are used widely in the research of molecular microstructure and conformation [16–21]. The fluorescence polarization method, which is a combination of fluorescence analysis and polarization technology, has been extensively applied to life sciences, clinical medicine, pharmaceutical analyses

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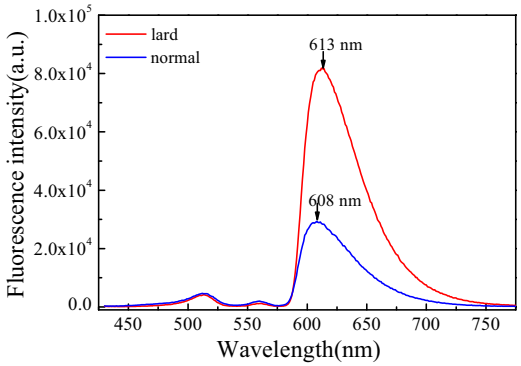

Fig. 1. Fluorescence spectra of whole blood solution of normal and lard diet mice induced by a laser with a wavelength of 407 nm.

and environmental sciences [22–27]. The objective of this study was to investigate the biological effects of SFAs. We measure the fluorescence polarization spectra of whole blood solution from mice that had a normal or lard diet. The fluorescence polarization degrees are calculated by the Stokes vectors parameters of light intensity. Through the comparison of blood fluorescence parameters, characteristics of lard (especially SFAs) and its influence on small white mice were analyzed. The research results can contribute to the study of edible oils and fats effects on living body, and can give further instruction to people's daily intake of dietary fat.

2. Experimental instrument and methods

2.1. Instrument

A Lifetime and Steady State Fluorimeter 900 (FLS900) combined with fluorescence lifetime & steady-state spectrometers made in Edinburgh Instruments Ltd. of UK were used for fluorescence measurements. The light source in steady-state spectrum was a semiconductor laser with a power of 5 mW, a wavelength of 407 nm, a pulse of 73 ps and a repetition rate of 80 MHz. The polarization device was a Glan Thompson prism and the scanning interval was 430–780 nm.

2.2. Samples and methods

The experiment animals, small white mice, were offered by Center of animal experimentation, Xuzhou Medical College. These mice were divided into two groups based upon their diet. One group was feed normally for half a year, and the other group was fed lard for half a year. Blood samples from each group were taken from the eyes of the mice. The 5% anticoagulant heparin was injected into the blood in order to obtain the whole blood solution. Then, a saline was used to dilute the solution to 0.8%, 1%, 2%, 3%, 4%, 5%, 6%, 7%, 7.5% and 8%, respectively.

A non-fluorescence quartz colorimetric utensil was also employed in this experiment, and its polarization angles were set to 0°, 35°, 55° and 90°, respectively. The fluorescence polarization spectrum for each sample was measured for over three times. The measured spectra were stable on the whole. All the experiments were conducted at room temperature.

3. Results

3.1. Fluorescence spectra of whole blood solution in vitro

Fig. 1 shows the fluorescence spectra of whole blood solution of normal and lard diet intake mice induced by a laser. From this figure, we can see that the fluorescence spectrum shape from the lard diet intake mouse is similar to that from normal one. There are three obvious fluorescence peaks for each spectrum located approximately at 515 nm, 559 nm and 612 nm, respectively. According to Peng [28], the fluorescence peak of 559 nm is not emitted by fluorophore but caused by absorption. The fluorescence peaks at 515 nm are the same for each spectrum. Therefore, we pay more attention to the change of the fluorescence peaks corresponding to 612 nm, which is induced by porphyrin of blood [29–32]. In addition, there is a weaker fluorescence peak for each spectrum located at 460 nm, which is induced by deionized water and heparin, and Raman scattering is more significant in lower concentration blood [33–35].

3.2. Polarization fluorescence spectra of whole blood solution in vitro

In this experiment, we find that the fluorescence emission and intesity is varies with the change of polarization angle when the whole blood solution is excided. The changed polarization angles were measured at angles of 0°, 35°, 55° and 90°,